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TRANSMITTING OR RECEIVING ARRANGEMENT FOR CONCENTRATED ELECTRIC WAVES

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Fig. 2.

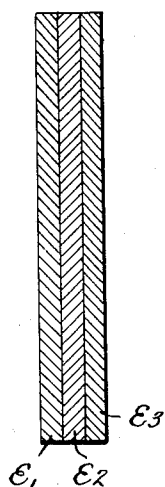


Fig. 1.

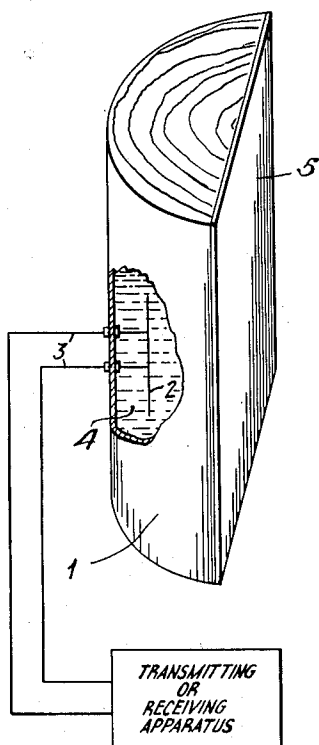


Fig. 3.



Porous Clay

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TRANSMITTING OR RECEIVING ARRANGEMENT FOR CONCENTRATED ELECTRIC WAVES

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4 Claims. (Cl. 250—11)

The invention relates to a transmitting or receiving arrangement for electric waves preferably of very short length such as between about 10 cm. and 300 cm.

As distinct from longer waves the above mentioned wave range is particularly suited for producing rays, for instance, for direction finding since the oscillations within this range are propagated "quasi optically" i. e. approximately in a straight line. It is well known that transmitters and receivers, operating with such waves may be provided with antenna systems for the purpose of concentrating the energy or for attaining outspoken directive effects; these antenna systems cooperating with suitable reflectors, which for the sake of simplicity are referred to in the following description as reflectors. The sharpness of the concentration of the rays produced by reflectors, or the resulting concentration of energy is in general the greater, the greater the ratio of the linear dimensions to the wave length; consequently in view of the necessary requirements as to the sharpness of the concentration, the reflectors obtained in practice are in many cases of inconvenient size. This inconvenience is primarily objectionable where portable apparatus is concerned. The present invention has for its purpose to obtain smaller reflector dimensions for a given sharpness of concentration, or else to enable the use of relatively larger wave lengths for a given maximum size of the reflector without sacrificing sharpness of concentration.

The invention makes use of the known Maxwell's relation

$$\lambda = \frac{\lambda_0}{\sqrt{\epsilon\mu}}$$

which shows the proportion by which the wave length of a given frequency changes when the propagation of the wave does not take place in a vacuum, but in a medium with the dielectric constant ϵ and having permeability μ (where λ_0 is the vacuum wave length and λ designates the wave length in the respective medium). For electric non-conductors which as such only have here to be reckoned with μ must always be assumed equal to 1 as being a sufficient approximation, whereas ϵ may assume very high values for some materials (for instance for water $\epsilon=81$). Therefore the wave length of a given oscillation, for instance, in water is reduced to the

$$\sqrt{81} \text{ i. e. } \frac{1}{9}$$

In accordance with the present invention a reflector is provided at the transmitter or receiver of an ultra short wave beam installation and which is surrounded with an insulating material with a high dielectric constant provided at least at the surface of reflection. The reduction of the wave length, occurring in this medium, has a favorable effect as regards sharpness of concentration, or concentration of energy respectively, as to the meaning of the previous statements, since besides other effects, due to this measure the ratio, size of reflector to wave length is increased.

Figure 1 of the drawing illustrates schematically a practically approved embodiment. Figures 2 and 3 illustrate different closure plates which may be used. Referring to Figure 1, 1 designates a solid parabolic cylindrical reflector which may consist of copper, or aluminum sheets. The three sides, open at first, are covered by insulating plates, whereby an all side closed container is formed which may be filled with water through a suitable opening, or any other liquid having a high dielectric constant may be used therefor. This liquid is indicated at 4 in a portion of the drawing broken away merely for purposes of illustration. In order to obtain an approximately parallel concentration of rays, the focal length of the paraboloid is preferably chosen about equal to 0.2 times the wave length in the liquid. A di-pole emitter 2 is arranged at the focal line and to which the oscillating energy is supplied through a Lecher wire system 3 passed through the reflector sheet. A closure plate 5 is indicated through which the rays are propagated.

Such an arrangement is likewise suited for the transmission and reception of directed short waves. It can be seen that not only liquids may serve as a wave shortening means, but also solid material having a high dielectric constant, such as for instance sulphur or paraffin.

It is particularly necessary to consider those phenomena, occurring at the transition of the directed radiation from the wave shortening medium through the front cover plate of the reflector into the surrounding air. It must be borne in mind that hereby a certain fraction of the energy of radiation is reflected which (for the transmitter) is lost to the actual radiation. At the transition from one medium into a second medium the unused reflected portion r is quantitatively given by the Fresnel's relation:

$$r = \left(\frac{n-1}{n+1} \right)^2,$$

if n designates the electrical exponent of refraction

$$= \sqrt{\frac{\epsilon_1}{\epsilon_2}}$$

The remaining portion h of the total radiation which is passed through after reflection is

$$h = 1 - r = \frac{4n}{(n+1)^2}$$

For the direct transition from water into air only $h=36\%$ of the incident radiation would pass through the dividing surface in accordance with the above relation. This low efficiency would at first render the technical result of the described "water reflector" arrangement very questionable. A detailed analysis shows, however, that the calculated transition coefficient can be essentially increased if the transition from the electrically dense medium (water) into the electrically thin medium (air) does not take place in a single step, but through one or several interposed intermediate layers of stepped dielectric constant.

In the embodiment above described and shown in the drawing the transition takes place, for instance, from water into air by means of an insulating plate the dielectric constant of which may here be assumed $\epsilon=4$. According to Fresnel the following gradual diminutions are obtained:

At the first dividing layer ($n=4.5$): $h_1=59.5\%$ of incident energy

At the second dividing layer ($n=2$): $h_2=89\%$ h_1

Total amount transmitted $=h_1 \times h_2 = 53\% = 0.595 \times 0.89$

By providing further intermediate layers the all over efficiency can still be further improved. The following sequence is suggested: water ($\epsilon=81$)—glass ($\epsilon=9$)—hard rubber or pertinax ($\epsilon=3$)—air. The total efficiency for this combination is 64.5% . If it were possible to provide an infinite number of intermediate layers which enable a gradual transition of the dielectric constant, the total efficiency could be increased to 100% i. e. all reflection losses could be eliminated. Figure 2 shows a closure plate built up of strata having graduated dielectric constants E_1 , E_2 and E_3 which may be used in the apparatus of Figure

1. This condition may be practically approached by covering the liquid reflector with a porous clay wall absorbing the liquid at its inside, but remaining dry however at its outside due to evaporation. Figure 3 illustrates a porous clay plate which may be used for the closure plate. Roughly considered and due to the still very long electric waves as compared with the optical waves the structure is more or less unimportant inasmuch as the figurative porous clay wall, partly absorbed by the liquid, represents a medium the dielectric constant of which decreases gradually from one side to the other side.

I claim:

1. In a communication system, in combination, a reflector comprising a container in the form of a section of a cylinder, a liquid having a high dielectric constant within said container and an antenna in said liquid at the focus of said reflector, a closure plate of insulating material for said reflector through which the waves radiated from said antenna are arranged to pass, the dielectric constant of said plate having a value between that of the liquid and air, and high frequency apparatus in circuit with said antenna.

2. In a communication system, in combination, a reflector comprising a container, a liquid having a high dielectric constant within said container and an antenna in said liquid at the focus of said reflector, a closure plate of insulating material for said reflector through which the waves radiated from said antenna are arranged to pass, said closure plate being formed of strata of materials having graduated dielectric constants, and high frequency apparatus in circuit with said antenna.

3. In a communication system, in combination, a reflector comprising a container, a liquid having a high dielectric constant within said container and an antenna in said liquid at the focus of said reflector, a porous clay closure plate for said reflector, said plate only partially absorbing the liquid medium within the container, and high frequency apparatus in circuit with said antenna.

4. A system in accordance with claim 2, characterized in this that said container is in the form of a parabolic cylinder.

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